

# Meteorological overview of the 2021 and 2022 DCTOSS deployment

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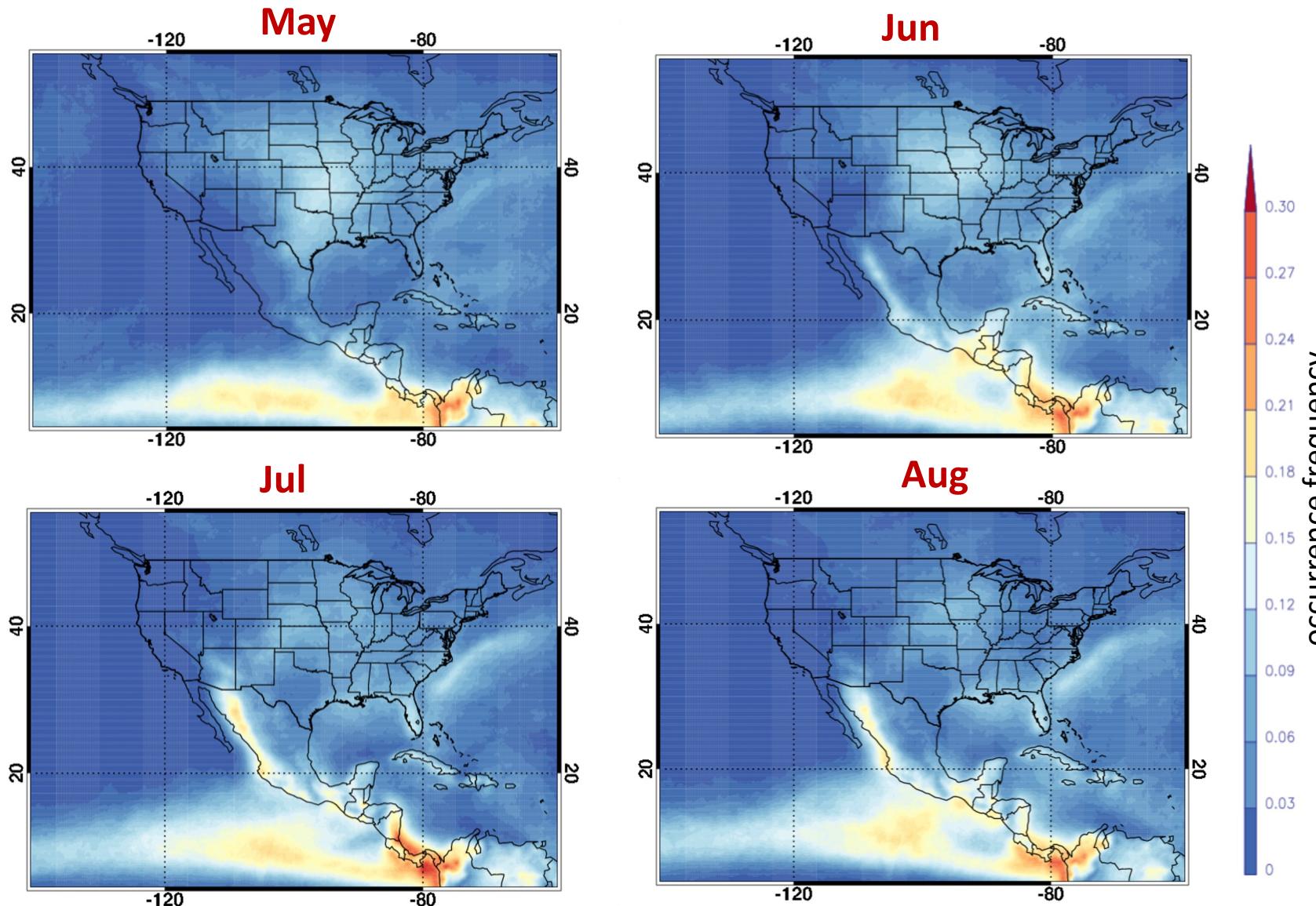
*Special thanks to Luis Millán for the MLS data and plots!*

# Topics

- Convective activity over the North American Monsoon region
- Overshooting convection over CONUS
- North American Monsoon anticyclone (NAMA)
- Lower stratospheric tracers ( $O_3$  and  $H_2O$ ) over NAMA

# Convection occurrence frequency (2006-2022)

(GPM MERG IR brightness temperature <235 K)

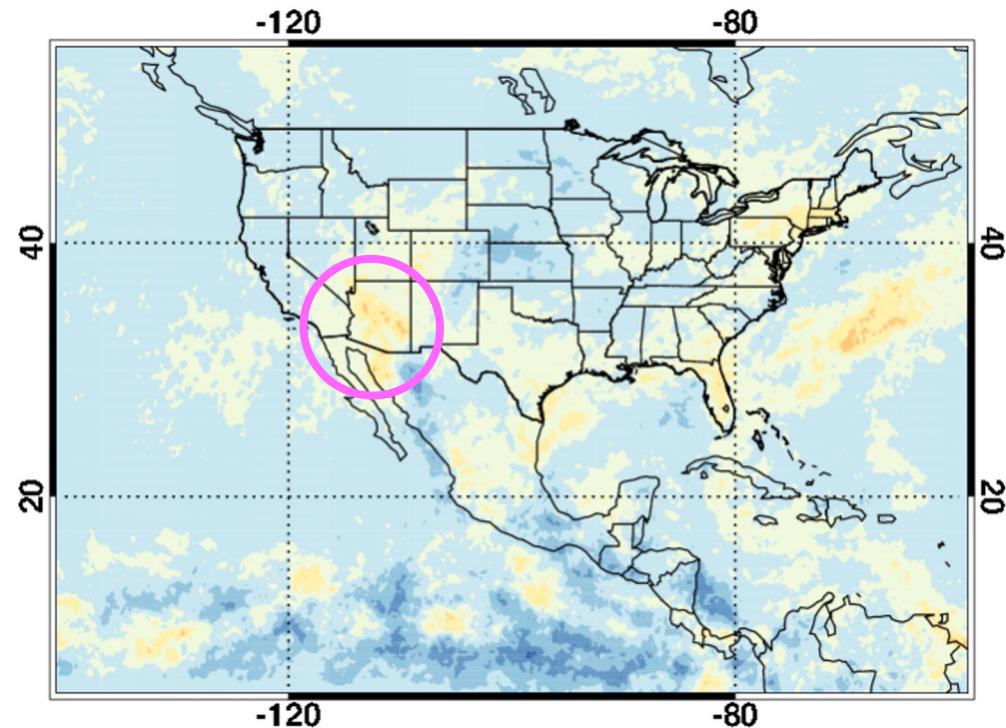


- Relatively frequent convective activity over the Central Plains in May and June
- Convective activity over Sierra Madre peaks around July and August

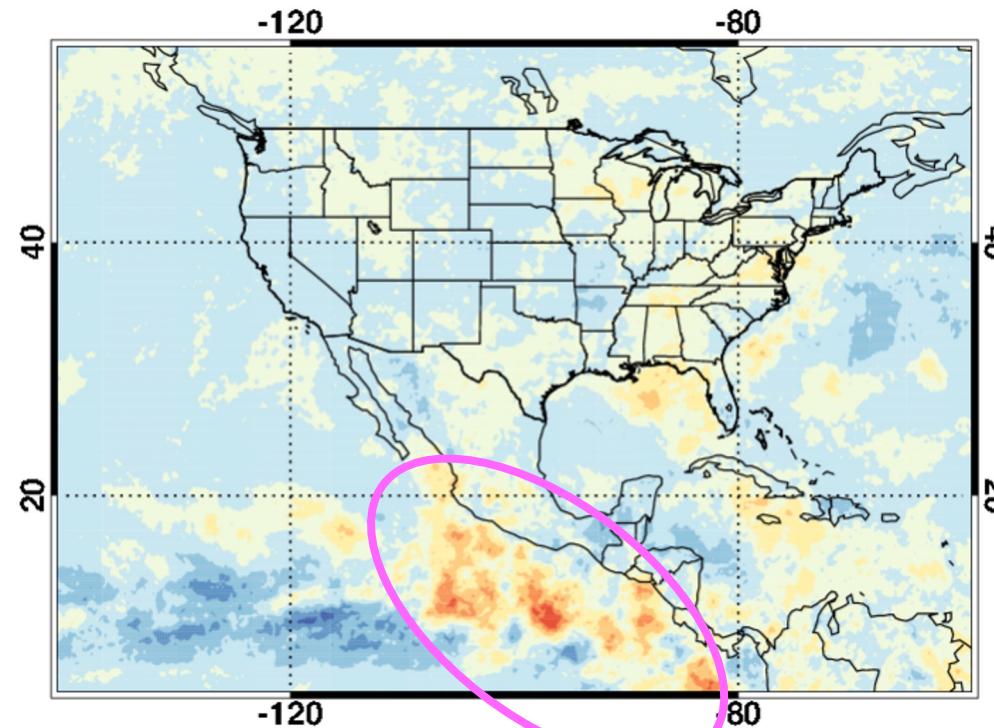
# Convection occurrence frequency (2021 deployment)

(GPM MERG IR brightness temperature >235 K)

**July anomaly (2021 - climo)**



**Aug anomaly (2021 - climo)**

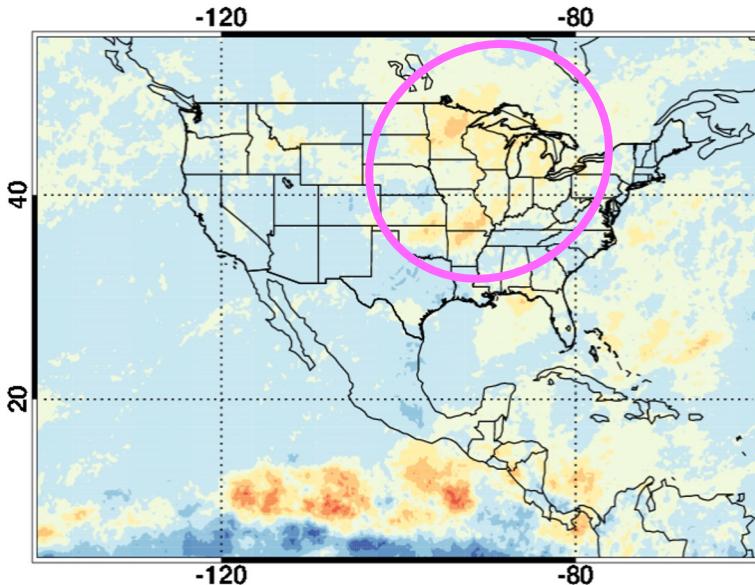


- Convective activity is slightly below average in Jul 2021, except for small enhancement over southwestern U.S.
- Convective activity over CONUS is similar to climatology in Aug 2021, but more frequent over the tropical eastern Pacific (closer to the coast).
- Mexican convection shows regional anomalies, but overall close to climatology or slightly weaker in northern Sierra Madre.

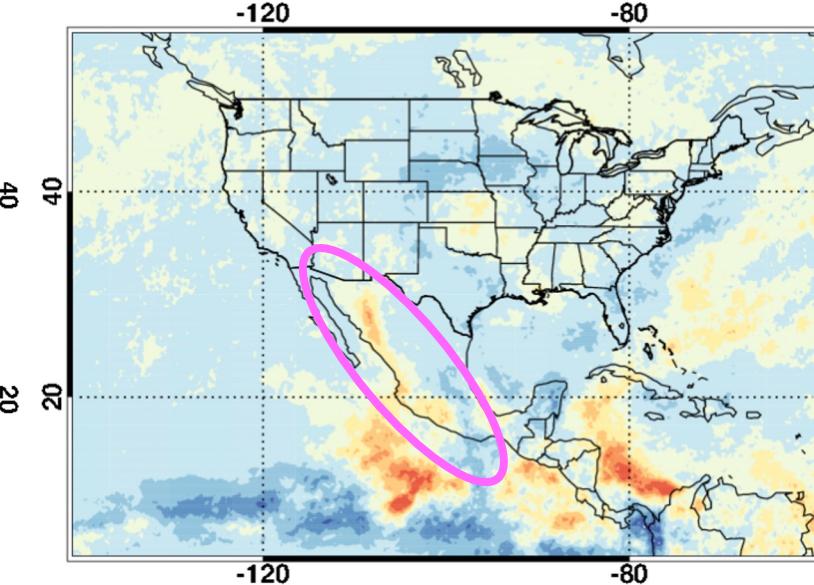
# Convection occurrence frequency (2022 deployment)

(GPM MERG IR brightness temperature >235 K)

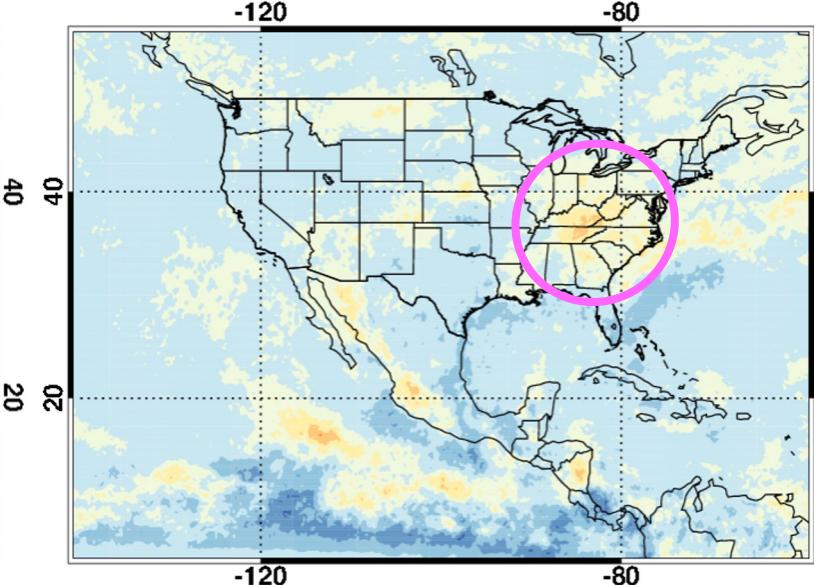
**May anomaly (2022 - climo)**



**Jun anomaly (2022 - climo)**



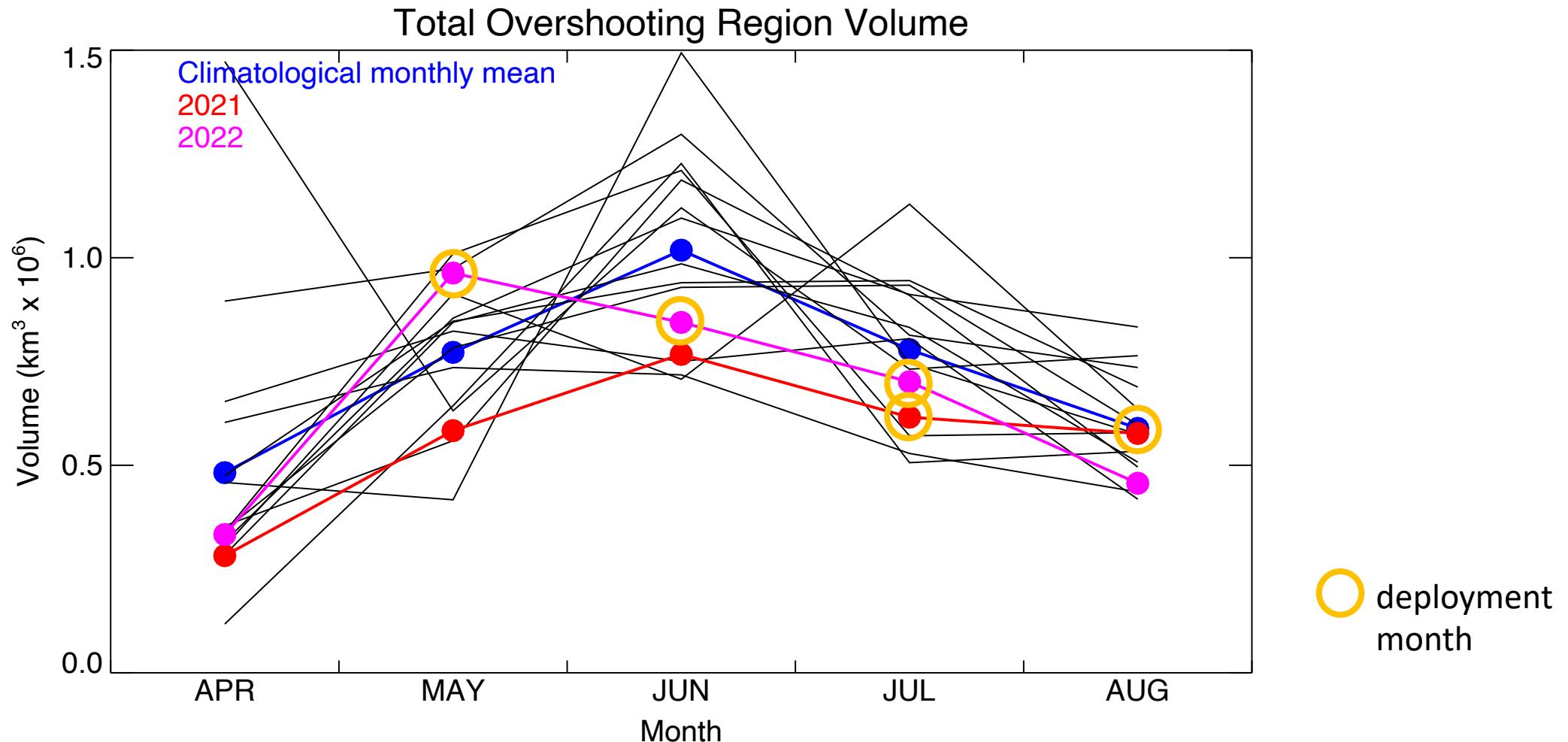
**Jul anomaly (2022 - climo)**



- In May 2022, above average convective activity is seen over the Midwestern U.S.
- Convective activity over CONUS is slightly below average (especially near Nebraska, Iowa) in Jun 2022.
- Anomalously frequent convection is observed over the Sierra Madre in Jun 2022 (early start of Mexican convection).
- Slightly enhanced convective activity is seen over Kentucky/Tennessee in Jul 2022.

# Overshooting convection frequency (2008-2022)

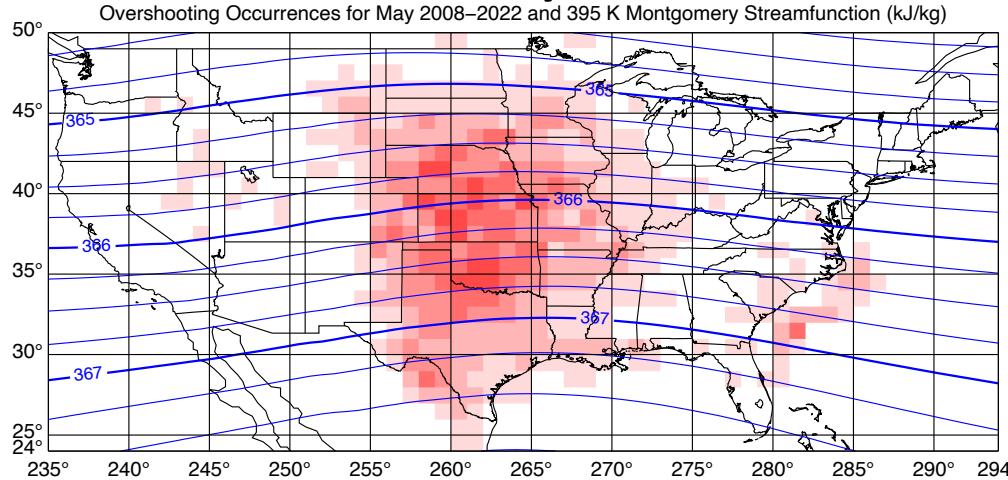
Radar and overshoot climatology using GridRad v4.2



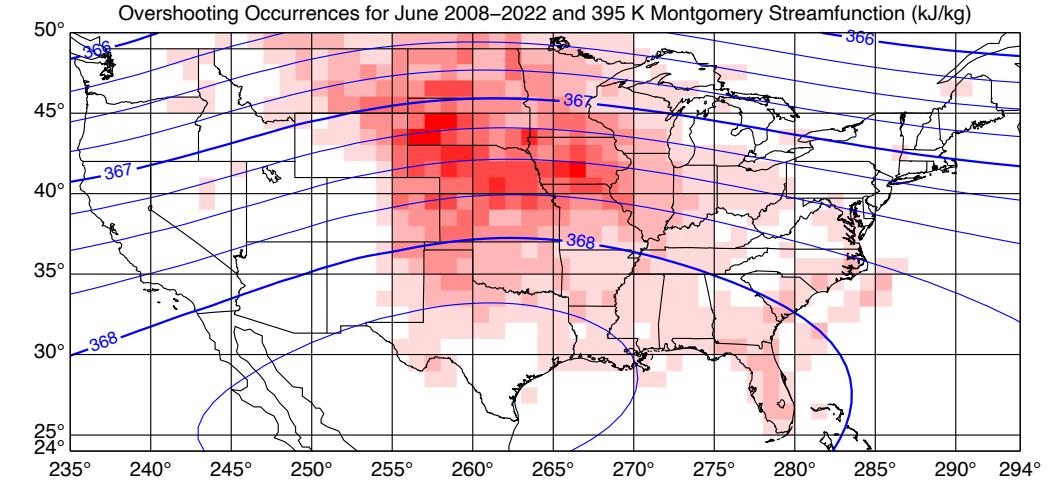
# NAM anticyclone and overshoot convection (2008-22)

ERA5 streamfunction and GridRad-based overshoot occurrence

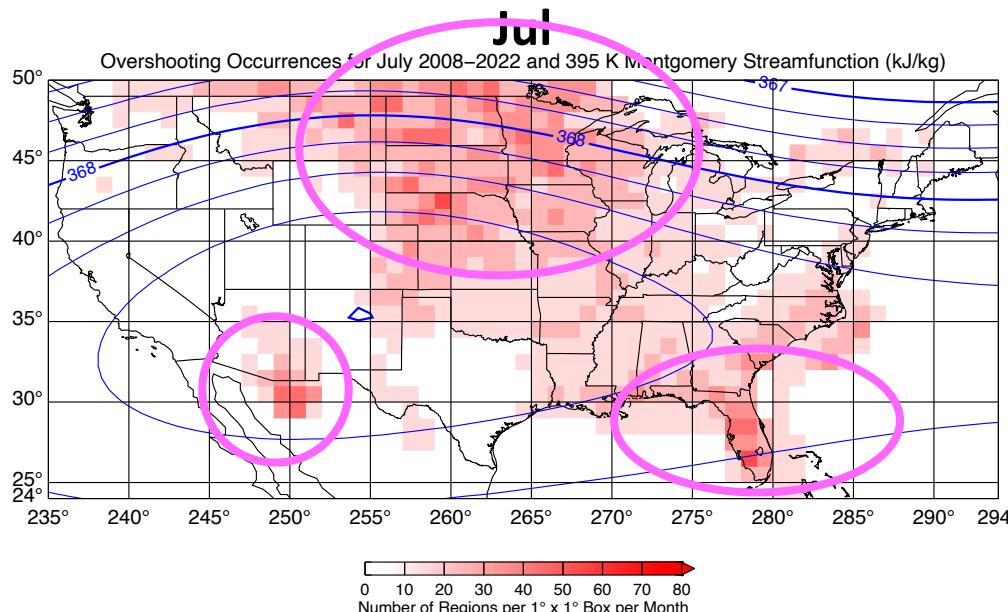
**May**



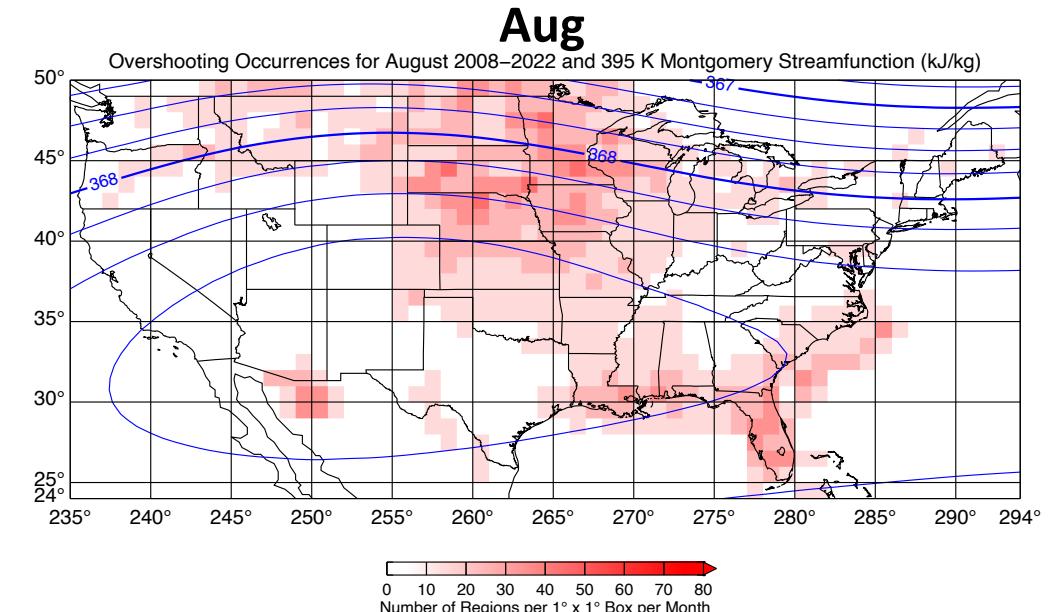
**Jun**



**Jul**



**Aug**



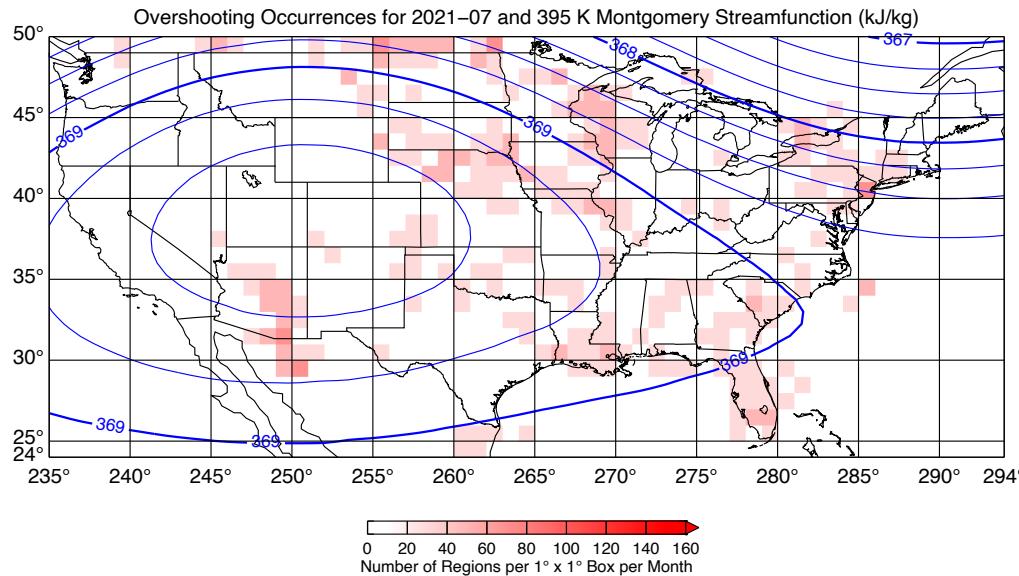
0 10 20 30 40 50 60 70 80  
Number of Regions per  $1^\circ \times 1^\circ$  Box per Month

0 10 20 30 40 50 60 70 80  
Number of Regions per  $1^\circ \times 1^\circ$  Box per Month

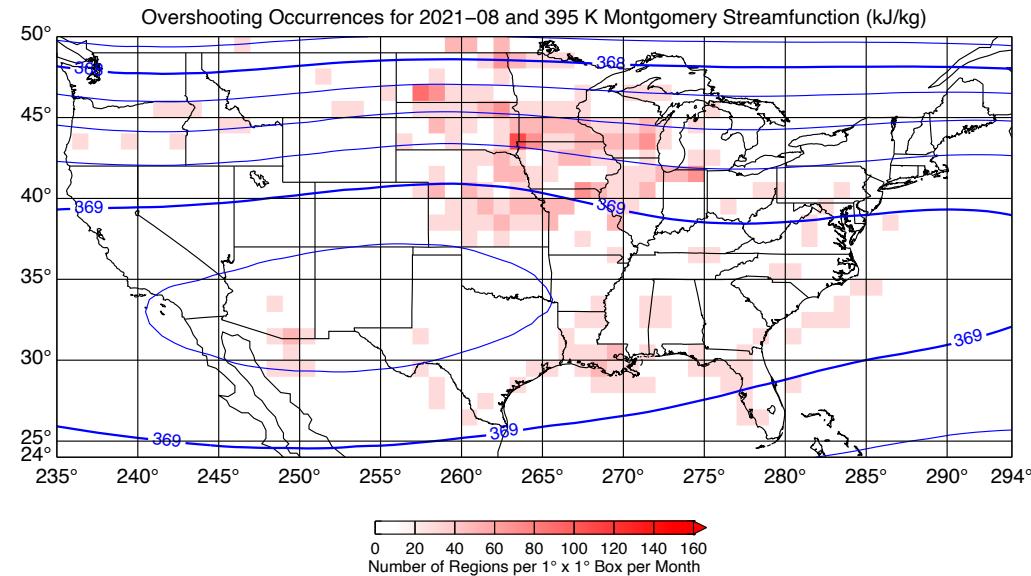
# NAM anticyclone and overshoot convection (2021)

ERA5 streamfunction and GridRad-based overshoot occurrence

**Jul 2021**



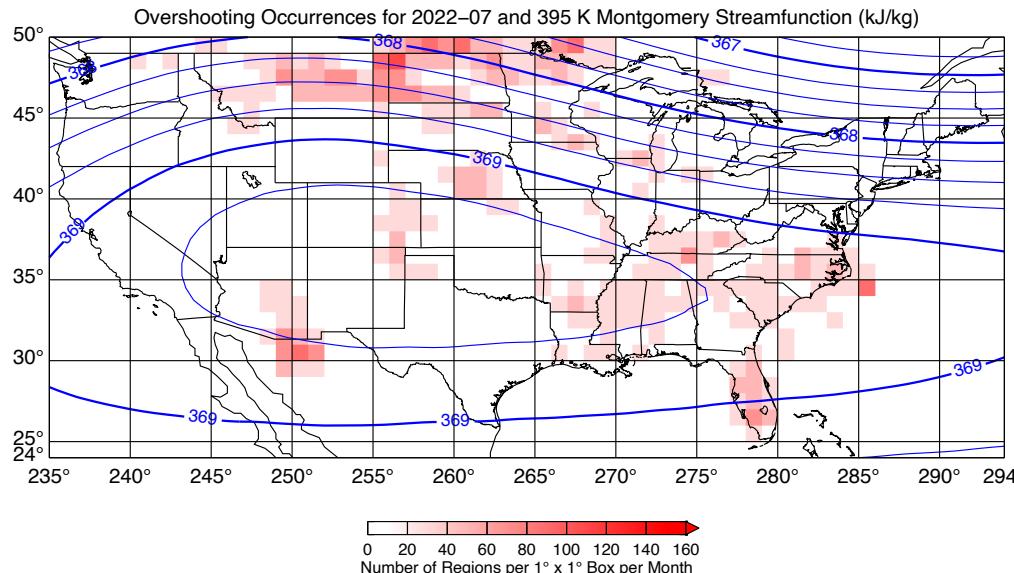
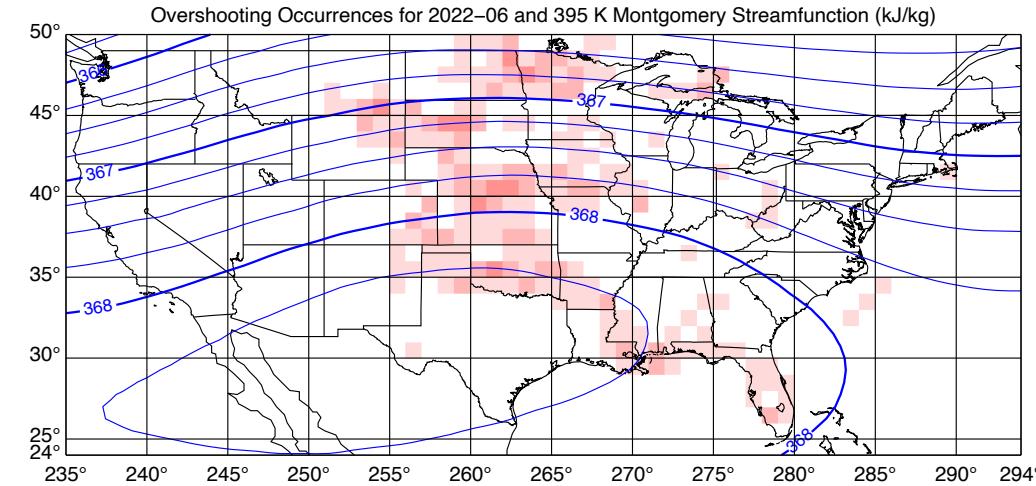
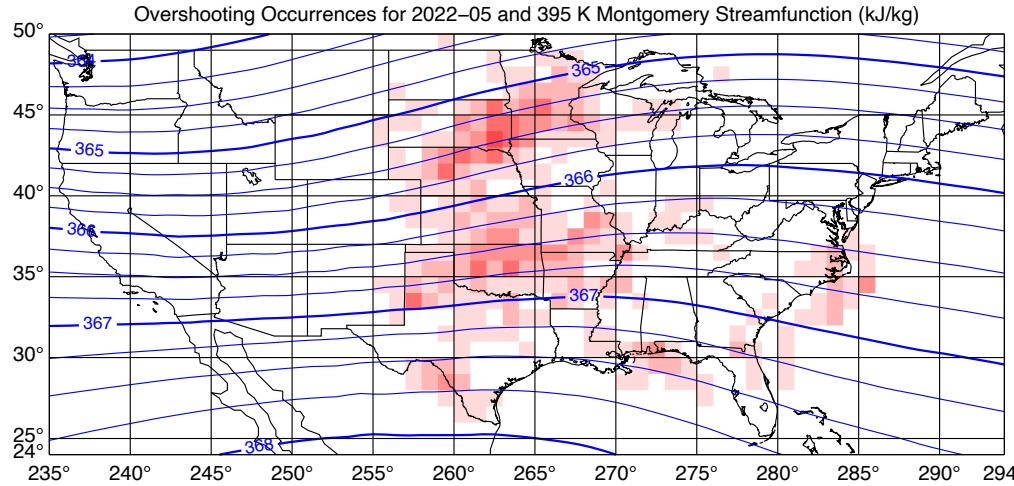
**Aug 2021**



- Strong NAMA and below average overshoots in Jul 2021
- Pattern of overshoot occurrences in Jul 2021 is similar to climatology, but relatively more overshoots in SWUS and less over the Midwestern U.S.
- Broad NAMA in Aug 2021 with overshoots focused over the Midwestern U.S.

# NAM anticyclone and overshoot convection (2022)

ERA5 streamfunction and GridRad-based overshoot occurrence

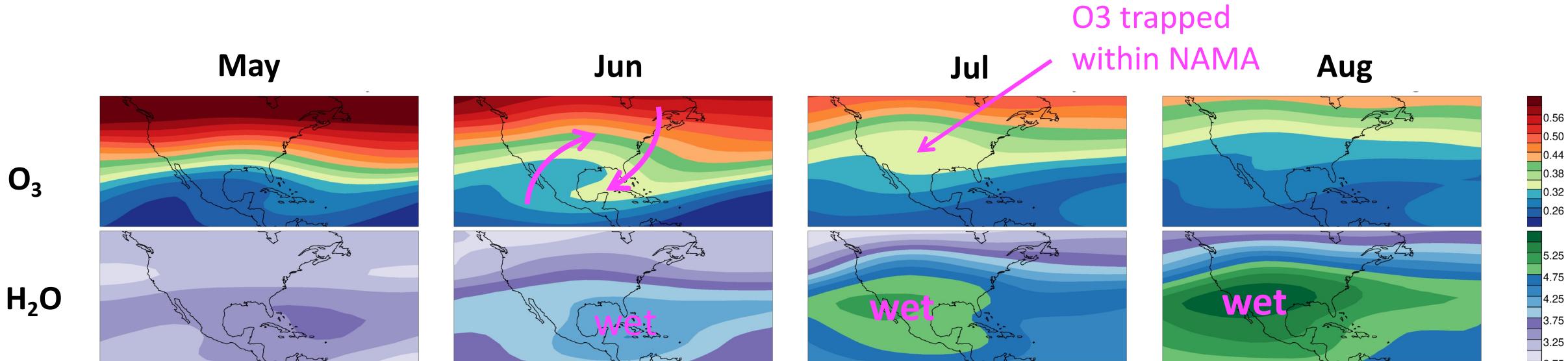


- Many overshoots in the Central Plains in May 2022 (two bands similar to brightness temperature pattern), leading to above average occurrence.
- Occurrences diminish in June (opposite of climatology)
  - NAMA in May and Jun 2022 were similar to climatology.
- Pattern of overshoots in Jul 2022 shows the three centers as in climatology, but relatively increased occurrence over Kentucky, Tennessee. NAMA was anomalously strong.

# Lower-stratospheric O<sub>3</sub> and H<sub>2</sub>O (2005-2022)

Aura MLS tracers at 390K

(courtesy of Luis Millán)

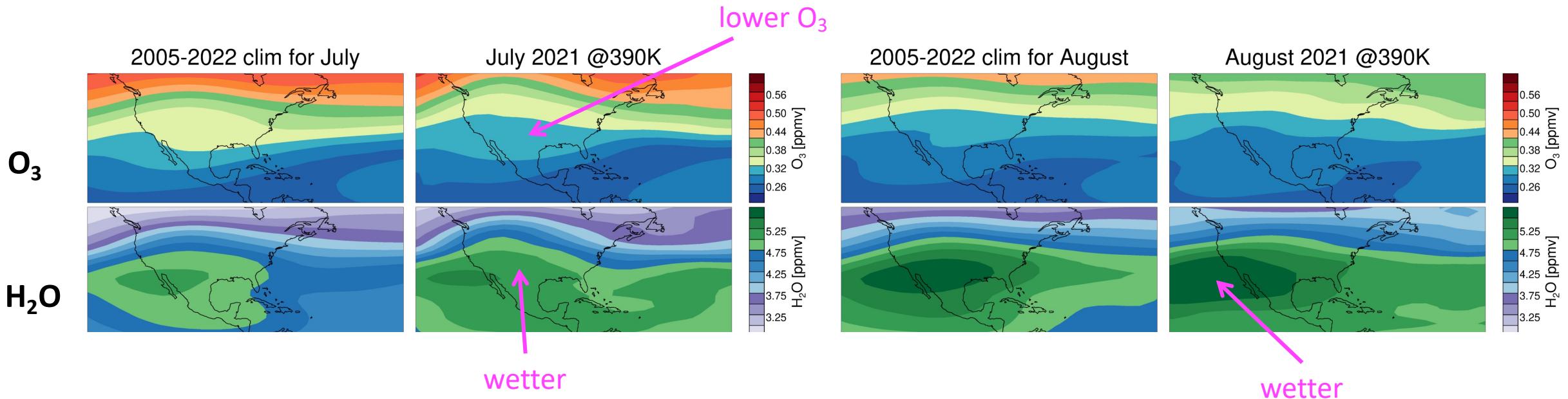


- NAMA perturbs the tracer fields in the lower stratosphere.
- O<sub>3</sub> and H<sub>2</sub>O distributions are relatively zonally symmetric in May.
- As NAMA develops in June, high O<sub>3</sub> (and low CO) air is transported equatorward on the eastern side (vice versa on the western side). H<sub>2</sub>O begins to increase within the anticyclone.
- H<sub>2</sub>O is significantly enhanced inside the NAMA in July and August.
- Relatively uniform O<sub>3</sub> is observed within the NAMA in July, with decreasing concentration in August.

# Lower-stratospheric O<sub>3</sub> and H<sub>2</sub>O (2021)

Aura MLS tracers at 390K

(courtesy of Luis Millán)

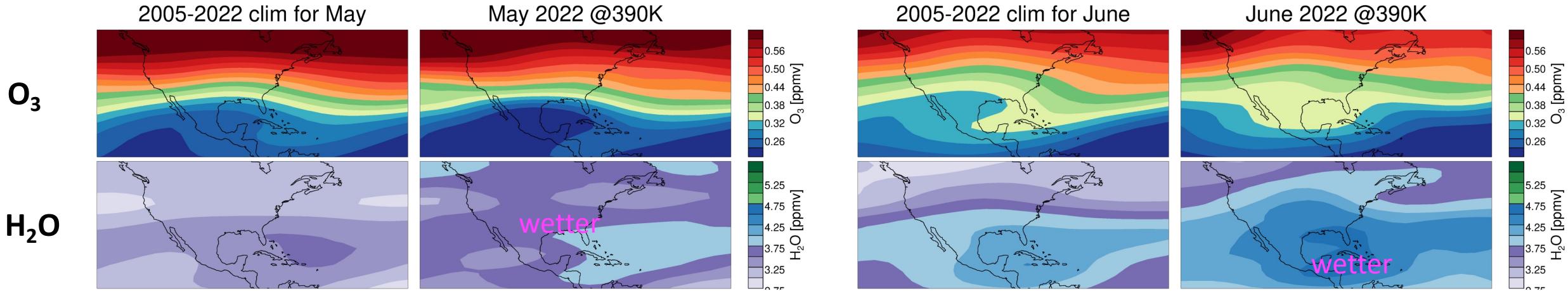


- Less O<sub>3</sub> (-30 ppb) than climatology in July 2021 in the southern part of U.S., while weaker meridional gradient in O<sub>3</sub> was observed in northern U.S. in August 2021.
- July 2021 was wetter (+0.2 ppmv) than climatology within the NAMA (i.e., SW flight domain).
- August 2021 was also generally wetter within the NAMA, but concentrations within our flight domain appear to be similar to climatology.

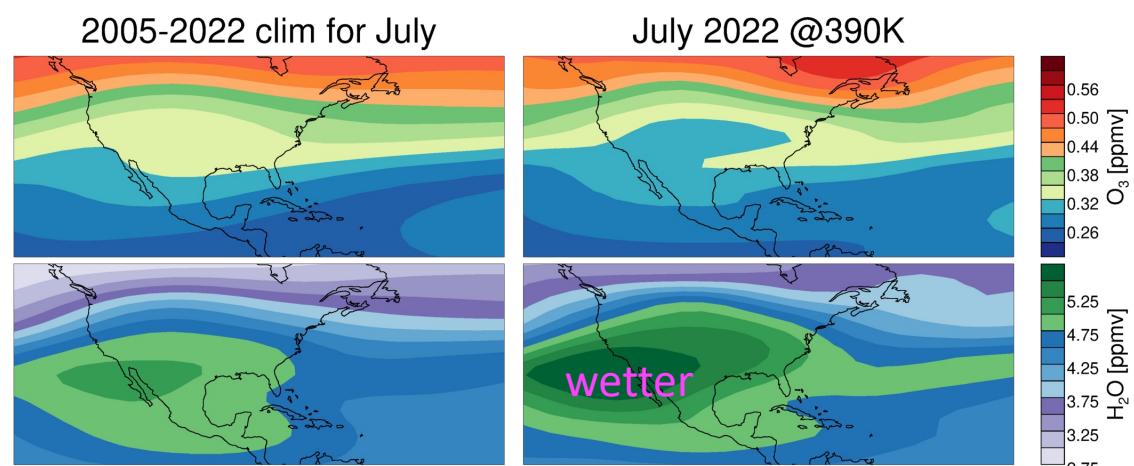
# Lower-stratospheric O<sub>3</sub> and H<sub>2</sub>O (2022)

Aura MLS tracers at 390K

(courtesy of Luis Millán)



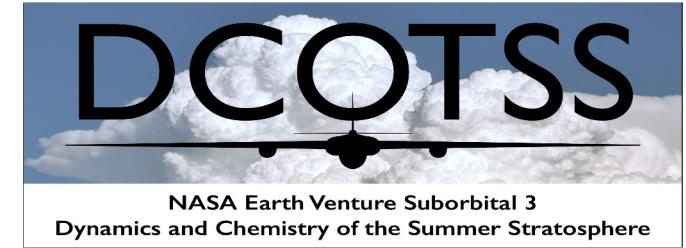
- O<sub>3</sub> mixing ratios in the northern domain were similar to climatology in May-Jul 2022. O<sub>3</sub> in the southern part of U.S. was slightly higher than climatology in June 2022 while it was lower than climatology in July 2022.
- H<sub>2</sub>O was significantly higher (up to +0.5 ppmv) than climatology in all three months.



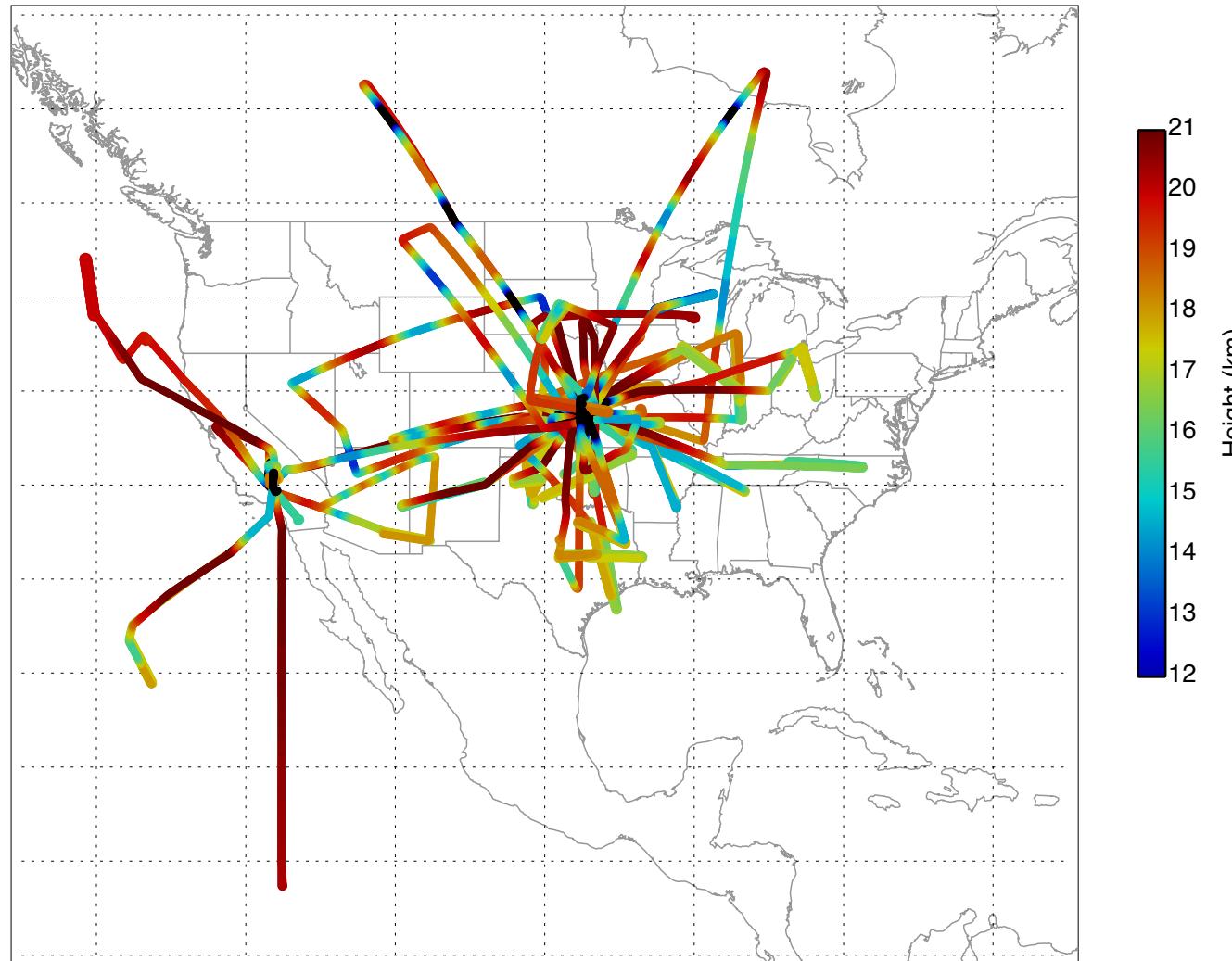
# Summary

- NAM anticyclone was anomalously strong during the 2021 (Jul-Aug) deployment as well as towards the end of the 2022 deployment (Jul).
- Convective (overshoot) activity over CONUS was below average during most of our 2021 and 2022 deployment, except during May 2022 when anomalously frequent deep convection was observed over the Midwestern U.S.
- Sierra Madre convection started early in June 2022 and remained relatively strong through July, allowing us to sample its outflow during 2022 deployment.
- Despite the relatively infrequent overshooting convection during our deployment months, the lower stratosphere over NAM was anomalously wet, especially in summer 2022.
- Lower stratospheric ozone distribution within our flight domain was generally similar to climatology, though with larger perturbations to the south.

# Science flights in 2021 and 2022

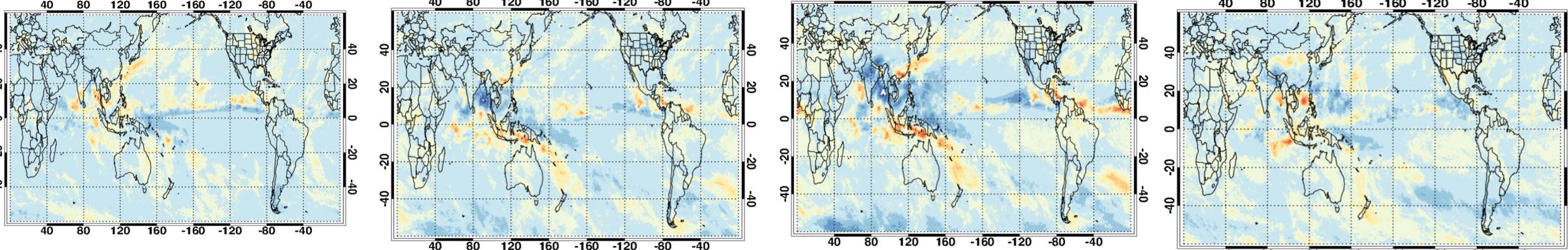
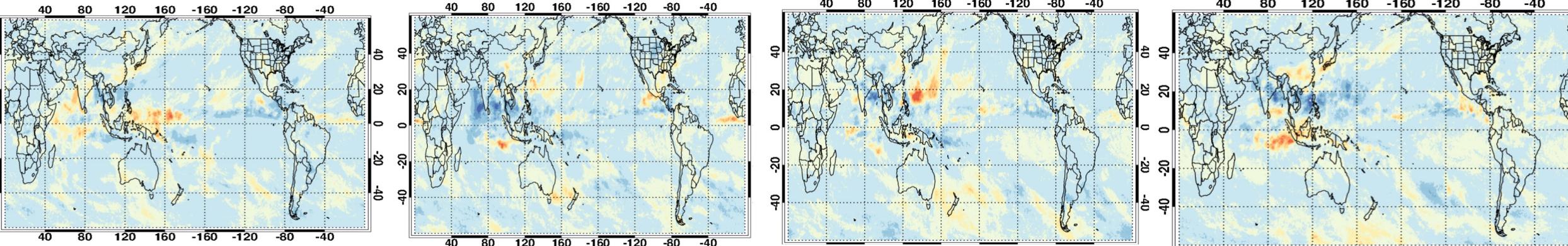
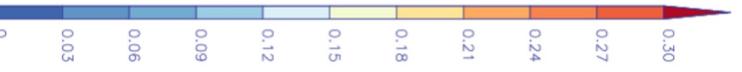
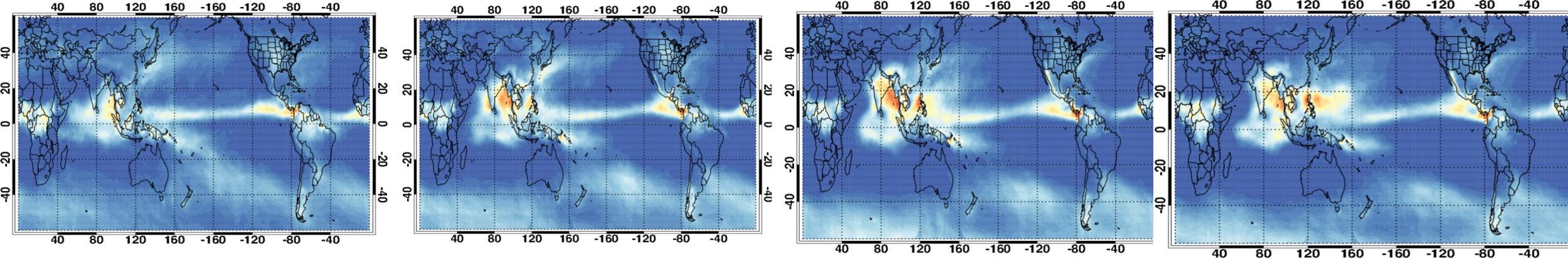


DCOTSS Flight Paths

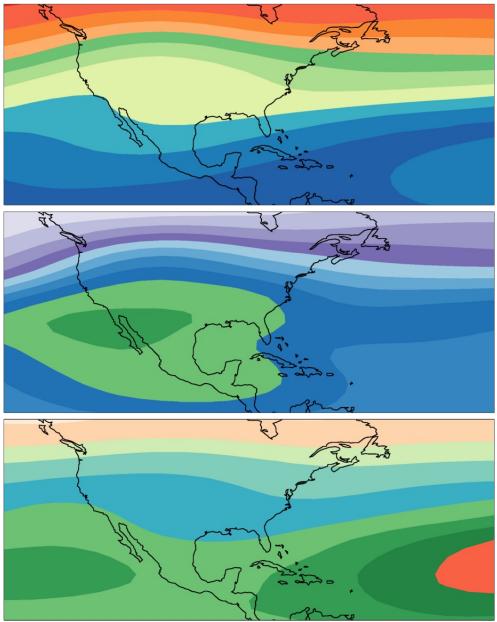


- 11 science flights in 2021 (Jul 16 – Aug 19)
- 12 science flights in 2022 (May 29 - Jul 11)

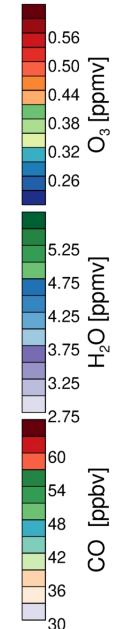
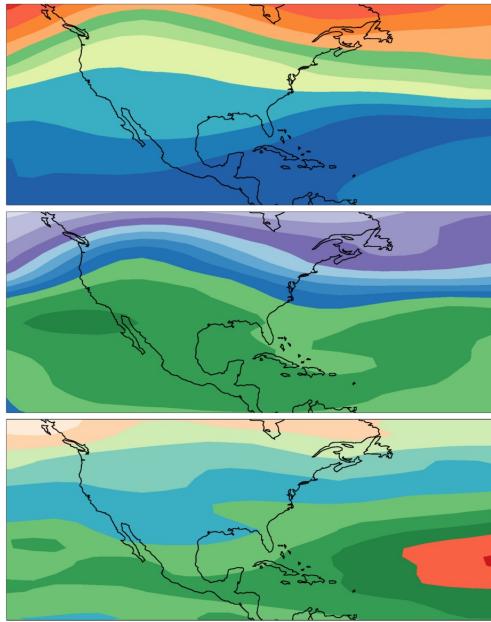
(courtesy E. Jensen)



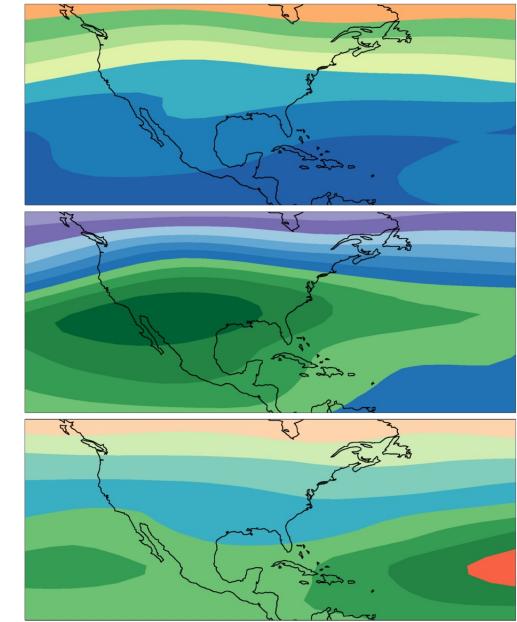
2005-2022 clim for July



July 2021 @390K



2005-2022 clim for August



August 2021 @390K

